

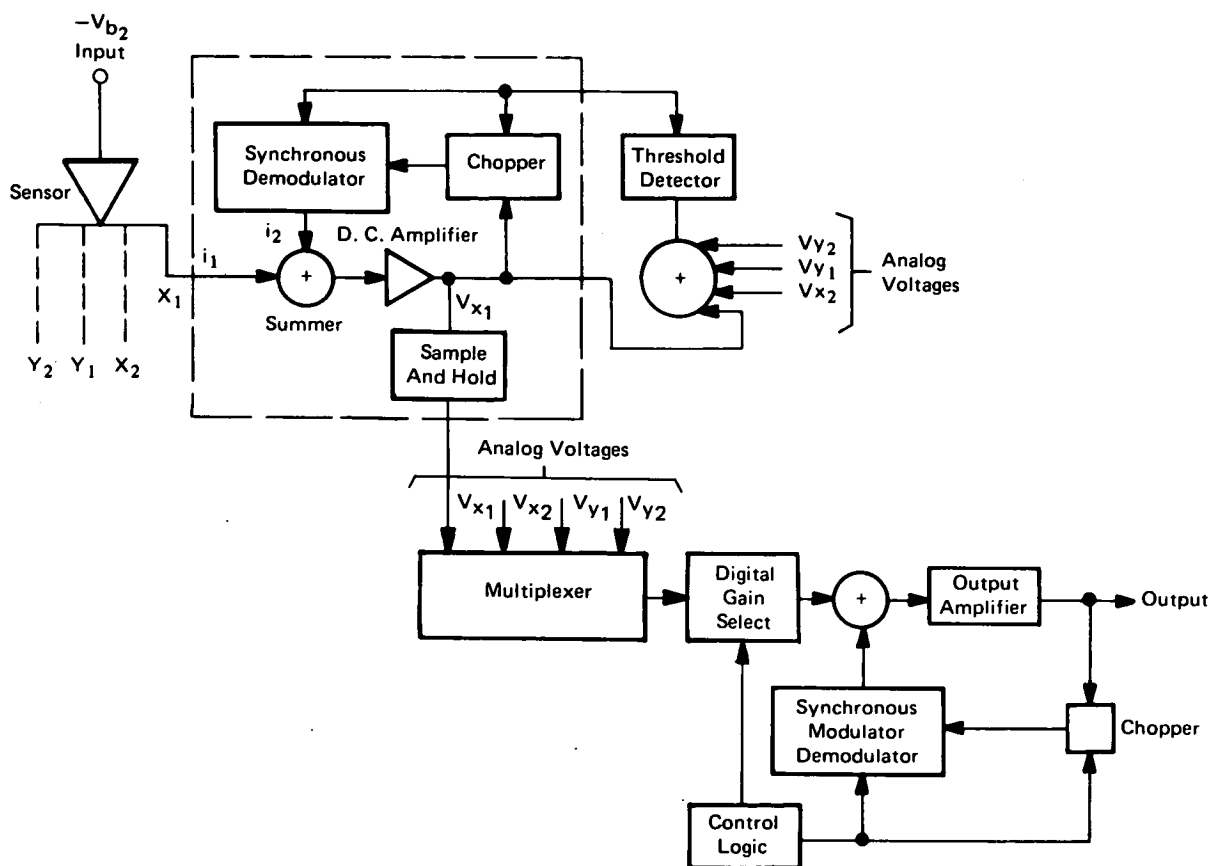
NASA TECH BRIEF

Goddard Space Flight Center



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Solar Aspect Determination System



The problem:

Space vehicles such as sounding rockets and satellites are usually equipped with an instrument which measures their attitude coordinates in space. Often, one reference vector is determined from the position of either the sun or the moon relative to the space vehicle. The present instruments used for this type of recording include either analog sensors consisting of two photoconductive devices, or some pattern of slits in front of a photocell, or a slit reticle placed in front of a binary or gray-coded

pattern of photocells. The first is normally limited in bandwidth and is difficult to manufacture because it requires precise matching of components. The second is normally not sufficiently accurate (approximately 1° accuracy) and is only applicable to a spinning vehicle. The third approach is inherently precise, but is of itself, one dimensional and becomes quite expensive when high resolution measurements ($< 1/4$ degree) are required.

(continued overleaf)

The solution:

An efficient solar or lunar aspect sensor containing a commercially available solid-state position-sensitive light detector provides complete space-vehicle sun or moon vector information.

How it's done:

The sensor, enclosed in a thermally-controlled light-tight housing, utilizes a pinhole (or lens) to admit a limited amount of light from the sun (or moon). This light is detected by silicon photodiodes of the PIN type (P-type intrinsic-N-type) which provide a very fast response (several nanoseconds to one microsecond). Current generated by PIN diodes then flows through a resistive substrate and emerges at four output terminals. Its magnitude at each terminal is determined by the position of the light beam on the detector surface. The four terminals provide complete attitude information in azimuth and elevation.

Electronics used in signal processing to determine a reference vector for a space vehicle are shown in the figure. Each of the four output terminals has an identical signal processing loop consisting of the summer, d.c. amplifier, chopper, and synchronous demodulator. The feedback loop consisting of these elements is incorporated to largely eliminate the dark current of the detector from the output signal. This technique both greatly increases the dynamic range of the instrument and eliminates a slowly varying source of error. When the instrument is intended for a spinning vehicle, the spin itself is used to derive the chopping signal from the threshold detector. For non-spinning vehicles, a rotating reticle must be used.

To avoid motion-induced errors, all output channels are sampled simultaneously by the sample and hold circuits. The multiplexer then delivers the sampled values to the output amplifier sequentially. Digital automatic gain control (AGC) is incorporated in the output amplifier to maintain a full dynamic range for varying light levels. The gain-select circuitry is enabled, immediately after the sample pulse, and all outputs associated with one measurement are then given the same weight. This feature is not required for solar aspect measure-

ment. A synchronous modulator-demodulator scheme is used to remove offsets generated through the multiplexer-output amplifier circuitry. The serial analog outputs from the output amplifier are delivered to appropriate encoding, storage, or display devices such as pulse code modulation (PCM) encoders or analog-to-digital converters. A control logic module supplies control to the output circuitry.

An essential part of the instrument is its calibration. This is accomplished by placing the detector on a calibration table with a suitable light source, and rotating the sensor through all of its field of view. Depending on the accuracy required, the calibration may be done by either analog or digital techniques, and data analysis can be done either manually or by computer having the calibration data stores in memory.

Less accurate instruments may be obtained at reduced cost by omitting dark current elimination, or digital AGC, or output offset elimination, or all of these.

Note:

Requests for further information may be directed to:
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Greenbelt, Maryland 20771
Reference: B73-10129

Patent status:

This invention is owned by NASA, and a patent application has been filed. Inquiries concerning non-exclusive or exclusive license for its commercial development should be addressed to:

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